CLAIMS

1. A signal processing device comprising:

a sampling circuit that samples an input signal and outputs a discrete signal composed of a string of sampling values;

a plurality of function generators that generate sampling functions with parameters m different from each other;

a plurality of inner product operating units for each of parameters m that take an inner product between the input signal and the sampling function and output an inner product operating value; and

a judging unit that determines parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and inner product operating values output from the plurality of inner product operating units and outputs the parameter m signal,

wherein a discrete signal composed of a string of the sampling values and the parameter m signal are outputted.

2. The signal processing device according to claim 1,

wherein the parameters m contain three types which are $m = 2, 3,$ and ∞.

3. The signal processing device according to claim 1,

wherein the parameters m contain four types which are $m = 1, 2, 3,$ and ∞.

4. The signal processing device according to claim 1,

wherein each of the plurality of errors is a sum of squares

of errors at sampling points within a predetermined span.

5. The signal processing device according to claim 1, wherein each of the plurality of errors is a sum of absolute values of errors at sampling points within a predetermined span.

6. The signal processing device according to claim 1, wherein each of the plurality of errors is the maximum of absolute values of errors at sampling points within a predetermined span.

7. The signal processing device according to claim 1, wherein the discrete signal is combined with the parameter m signal to form one signal.

8. The signal processing device according to claim 1, wherein the inner product operating unit includes:

a plurality of multipliers that multiply the input signal by the sampling function at every sampling point within a span where the sampling function is defined;

a plurality of integrators that integrate output signals from the plurality of multipliers; and

a switcher that switches output signals from the plurality of integrators in the order of sampling points to output the inner product operating value.

9. The signal processing device according to claim 1, wherein the input signal is an analog signal;

wherein the discrete signal and the parameter m signal are digital signals; and

wherein the signal processing device is an AD converter

that is supplied with the analog signal and outputs the digital signal.

10. A signal processing device comprising:

a sampling circuit that samples an input signal and outputs a sampling value;

a plurality of function generators that generate sampling functions with parameters m different from each other;

a plurality of inner product operating units for each of parameters m that take an inner product between the input signal and each of the sampling function and output an inner product operating value; and

a judging unit that determines parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and inner product operating values output from the plurality of inner product operating units and outputs the parameter m signal,

wherein the signal processing device outputs the parameter m signal and a discrete signal composed of a string of inner product operating values output from an inner product operating unit corresponding to parameter m giving the minimum error.

11. A signal processing device comprising:

a sampling circuit that samples an input signal and outputs a discrete signal composed of a string of sampling values;

a plurality of function generators that generate sampling functions with parameters m different from each other;

a plurality of inner product operating units for each

of parameters m that take an inner product between the input signal and each of the sampling function and output an inner product operating value;

a class judging unit that determines parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and inner product operating values output from the plurality of inner product operating units and outputs the parameter m signal; and

a switching point judging unit that, when a point allows errors of any parameters m to exceed a threshold value and parameter m changes in the vicinity of the point, determines the point to be a class switching point and outputs a switching point signal indicating the class switching point,

wherein the discrete signal composed of a string of sampling values, the parameter m signal, and the switching point signal are outputted.

12. A signal processing device,

wherein the signal processing device samples an input signal and outputs a signal indicating a sampling value,

wherein the signal processing device determines parameter m in a fluency signal space corresponding to the input signal, and

wherein the signal processing device outputs a combination of a signal indicating the sampling value and a signal indicating the parameter m.

13. A signal processing device,

wherein the signal processing device samples an input signal to acquire a sampling value,

wherein the signal processing device determines parameter m in a fluency signal space corresponding to the input signal;

wherein the signal processing device acquires a signal indicating an inner product operating value between the sampling value and a sampling function corresponding to the parameter m, and

wherein the signal processing device outputs a combination of a signal indicating the inner product operating value and a signal indicating the parameter m.

14. A signal processing method comprising the steps of:

sampling an input signal and outputting a discrete signal composed of a string of sampling values;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and outputting an inner product operating value for each parameter m;

determining parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and inner product operating value; and

outputting a discrete signal composed of a string of the sampling values and the parameter m signal.

15. A signal processing method comprising the steps of:

sampling an input signal and outputting a sampling value;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and outputting an inner product operating value for each parameter m;

determining parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and inner product operating value; and

outputting the parameter m signal and a discrete signal composed of a string of inner product operating values corresponding to parameter m giving the minimum error.

16. A signal processing method comprising the steps of:

sampling an input signal and outputting a discrete signal composed of a string of sampling values;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and outputting an inner product operating value for each parameter m;

determining parameter m providing a minimum error out of a plurality of errors composed of differences between the sampling value and inner product operating value; and

when a point allows errors of any parameters m to exceed a threshold value and parameter m changes in the vicinity of the point, determining the point to be a class switching point and outputs a switching point signal indicating the class

switching point; and

outputting the discrete signal composed of a string of sampling values, the parameter m signal, and the switching point signal.

17. A signal processing method comprising the steps of:

sampling an input signal and outputting a signal indicating a sampling value;

determining parameter m in a fluency signal space corresponding to the input signal; and

outputting a combination of a signal indicating the sampling value and a signal indicating the parameter m.

18. A signal processing method comprising the steps of:

sampling an input signal to acquire a sampling value;

determining parameter m in a fluency signal space corresponding to the input signal;

acquiring a signal indicating an inner product operating value between the sampling value and a sampling function corresponding to the parameter m; and

outputting a combination of a signal indicating the inner product operating value and a signal indicating the parameter m.

19. A signal processing program making a computer execute the steps of:

sampling an input signal and outputting a discrete signal composed of a string of sampling values;

generating a plurality of sampling functions with

parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and outputting an inner product operating value for each parameter m;

determining parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and the inner product operating value; and

outputting a discrete signal composed of a string of the sampling values and the parameter m signal.

20. A signal processing program making a computer execute the steps of:

sampling an input signal and outputting a signal indicating a sampling value;

determining parameter m in a fluency signal space corresponding to the input signal; and

outputting a combination of a signal indicating the sampling value and a signal indicating the parameter m.

21. A recording medium recording a signal processing program for a computer to process input signals, wherein the signal processing program makes a computer execute the steps of:

sampling an input signal and output a discrete signal composed of a string of sampling values;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each

of the plurality of sampling functions and output an inner product operating value for each parameter m;

determining parameter m providing a minimum error out of a plurality of errors composed of differences between the sampling value and inner product operating value; and

outputting a discrete signal composed of a string of the sampling values and the parameter m signal.

22. A recording medium recording a signal processing program for a computer to process input signals, wherein the signal processing program makes a computer execute the steps of:

sampling an input signal and output a signal indicating a sampling value;

determining parameter m in a fluency signal space corresponding to the input signal; and

outputting a combination of a signal indicating the sampling value and a signal indicating the parameter m.

23. A signal processing device comprising:

a plurality of function generators that generate inverse sampling functions with parameters m different from each other;

when input signals include a discrete signal for an original signal belonging to parameter m_0 of the parameters m and a parameter m signal indicating the parameter m_0,

a function selector that uses the parameter m signal of the input signals to select an inverse sampling function with the parameter m_0 out of the inverse sampling functions; and

a convoluting integrator that performs convolution integration between the discrete signal and the selected inverse sampling function with parameter m_0 to acquire a continuous waveform signal.

24. The signal processing device according to claim 23, wherein the parameters m contain three types which are m = 2, 3, and ∞.

25. The signal processing device according to claim 23, wherein the parameters m contain four types which are m = 1, 2, 3, and ∞.

26. The signal processing device according to claim 23, wherein the convoluting integrator includes:

a plurality of multipliers to multiply the inverse sampling function by a holding signal to hold the discrete signal during a span at every sampling point in the span for defining the inverse sampling function; and

an accumulator to accumulatively add output signals from the multipliers in the order of sampling points.

27. The signal processing device according to claim 23, wherein the input signal is a digital signal;

wherein the continuous waveform signal is an analog signal; and

wherein the signal processing device is a DA converter that is supplied with the digital signal and outputs the analog signal.

28. A signal processing device comprising:

a plurality of function generators that generate inverse sampling functions with parameters m different from each other;

when input signals include a discrete signal for an original signal belonging to parameter m_0 of the parameters m, a parameter m signal indicating the parameter m_0, and a switching point signal indicating a class switching point, a function selector that uses the parameter m signal and the switching point signal of the input signals to select an inverse sampling function with the parameter m_0 out of the inverse sampling functions; and

a convoluting integrator that performs convolution integration between the discrete signal and the selected inverse sampling function with parameter m_0 to acquire a continuous waveform signal.

29. A signal processing device,

wherein the signal processing device is supplied with a first signal indicating a sampling value output by sampling an original signal and with a second signal indicating parameter m in a fluency signal space for the original signal, and

wherein the signal processing device uses an inverse sampling function for the parameter m selected by the second signal to acquire a continuous waveform signal from the first signal.

30. A signal processing device,

wherein the signal processing device is supplied with a first signal indicating parameter m in a fluency signal space

for an original signal and with a second signal indicating an inner product operating value between a sampling value acquired by sampling the original signal and a sampling function with the parameter m, and

wherein the signal processing device uses an inverse sampling function with the parameter m selected by the first signal to acquire a continuous waveform signal from the second signal.

31. A signal processing method comprising the steps of:

generating a plurality of inverse sampling functions with parameters m different from each other;

supplying input signals including a discrete signal for an original signal belonging to parameter m_0 of the parameters m and a parameter m signal indicating the parameter m_0;

using the parameter m signal of the input signals to select an inverse sampling function with the parameter m_0 out of the plurality of inverse sampling functions; and

performing convolution integration between the discrete signal and the selected inverse sampling function with parameter m_0 to acquire a continuous waveform signal.

32. A signal processing method comprising the steps of:

generating a plurality of inverse sampling functions with parameters m different from each other;

supplying input signals including a discrete signal for an original signal belonging to parameter m_0 of the parameters m, a parameter m signal indicating the parameter m_0, and a

switching point signal indicating a class switching point;

using the parameter m signal and the switching point signal of the input signals to select an inverse sampling function with the parameter m_0 out of the plurality of inverse sampling functions; and

performing convolution integration between the discrete signal and the selected inverse sampling function with parameter m_0 to acquire a continuous waveform signal.

33. A signal processing method comprising the steps of:

inputting a first signal indicating a sampling value output by sampling an original signal and a second signal indicating parameter m in a fluency signal space for the original signal; and

using an inverse sampling function for the parameter m selected by the second signal to acquire a continuous waveform signal from the first signal.

34. A signal processing method comprising the steps of:

inputting a first signal indicating parameter m in a fluency signal space for an original signal and a second signal indicating an inner product operating value between a sampling value acquired by sampling the original signal and a sampling function with the parameter m; and

using an inverse sampling function with the parameter m selected by the first signal to acquire a continuous waveform signal from the second signal.

35. A signal processing program that makes a computer

execute the steps of:

generating a plurality of inverse sampling functions with parameters m different from each other;

supplying input signals including a discrete signal for an original signal belonging to parameter m_0 of the parameters m and a parameter m signal indicating the parameter m_0;

using the parameter m signal of the input signals to select an inverse sampling function with the parameter m_0 out of the plurality of inverse sampling functions; and

performing convolution integration between the discrete signal and the selected inverse sampling function with parameter m_0 to acquire a continuous waveform signal.

36. A signal processing program that makes a computer execute the steps of:

inputting a first signal indicating a sampling value output by sampling an original signal and a second signal indicating parameter m in a fluency signal space for the original signal; and

using an inverse sampling function for the parameter m selected by the second signal to acquire a continuous waveform signal from the first signal.

37. A recording medium recording a signal processing program that makes a computer execute the steps of:

generating a plurality of inverse sampling functions with parameters m different from each other;

supplying input signals including a discrete signal for

an original signal belonging to parameter m_0 of the parameters m and a parameter m signal indicating the parameter m_0;

using the parameter m signal of the input signals to select an inverse sampling function with the parameter m_0 out of the plurality of inverse sampling functions; and

performing convolution integration between the discrete signal and the selected inverse sampling function with parameter m_0 to acquire a continuous waveform signal.

38. A recording medium recording a signal processing program that makes a computer execute the steps of:

inputting a first signal indicating a sampling value output by sampling an original signal and a second signal indicating parameter m in a fluency signal space for the original signal; and

using an inverse sampling function for the parameter m selected by the second signal to acquire a continuous waveform signal from the first signal.

39. A signal processing device comprising:

a sampling circuit that samples an input signal to acquire a sampling value;

a plurality of function generators that generate sampling functions with parameters m different from each other; and

a plurality of inner product operating units for each of parameters m that take an inner product between the input signal and each of the sampling function and output an inner product operating value,

wherein, when there is a point at which a difference between the sampling value and inner product operating values output from the plurality of inner product operating units exceeds a specified threshold value with respect to any parameters m, the signal processing device determines the point to be a changing point and outputs a changing point signal indicating the changing point.

40. The signal processing device according to claim 39, wherein the parameters m contain three types which are $m = 2$, 3, and ∞.

41. The signal processing device according to claim 39, wherein the parameters m contain four types which are $m = 1$, 2, 3, and ∞.

42. The signal processing device according to claim 39, wherein the inner product operating unit includes:

a plurality of multipliers that multiply the input signal by the sampling function at every sampling point within a span where the sampling function is defined;

a plurality of integrators that integrate output signals from the plurality of multipliers; and

a switcher that switches output signals from the plurality of integrators in the order of sampling points to output the inner product operating value.

43. A signal processing device comprising:

a sampling circuit that samples an input signal to acquire a sampling value;

a function generator that generates a sampling function with parameter m;

an inner product operating unit that takes an inner product between the input signal and the sampling function and outputs an inner product operating value,

wherein, when there is a point at which a difference between the sampling value and the inner product operating value output from the inner product operating unit exceeds a specified threshold value, the signal processing device determines the point to be a changing point and outputs a changing point signal indicating the changing point.

44. A signal processing device comprising:

a sampling circuit that samples an input signal and outputs a discrete signal composed of a string of sampling values;

a plurality of function generators that generate sampling functions with parameters m different from each other;

a plurality of inner product operating units for each of parameters m that take an inner product between the input signal and the sampling function and output an inner product operating value;

a class judging unit that determines parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and inner product operating values output from the plurality of inner product operating units and outputs the parameter m signal; and

when there is a point at which the difference exceeds

a specified threshold value with respect to any parameters m, a changing point judging unit that determines that point to be a changing point and outputs a changing point signal indicating the changing point,

wherein a combination of the discrete signal, the parameter m signal, and the changing point signal are outputted.

45. A signal processing device,

wherein the signal processing device samples an input signal to acquire a sampling value; and

wherein the signal processing device detects a changing point for the input signal based on a difference between the sampling value and a value resulting from an inner product operation between the input signal and a sampling function corresponding to the input signal.

46. A signal processing device,

wherein the signal processing device samples an input signal and outputs a signal indicating a sampling value,

wherein the signal processing device determines parameter m in a fluency signal space corresponding to the input signal,

wherein, when there is a point at which a difference between the sampling value and a value resulting from an inner product operation between a sampling function and the input signal exceeds a specified threshold value with respect to any parameters m, the signal processing device determines the point to be a changing point, and

wherein the signal processing device outputs a combination

of a first signal indicating the sampling value, a second signal indicating the parameter m, and a third signal indicating the changing point.

47. A signal processing method comprising the steps of:

sampling an input signal to acquire a sampling value;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and outputting a plurality of inner product operating values; and

when there is a point at which a difference between the sampling value and the plurality of inner product operating values exceeds a specified threshold value with respect to any parameters m, determining the point to be a changing point and outputting a changing point signal indicating the changing point.

48. A signal processing method comprising the steps of:

sampling an input signal to acquire a sampling value;

generating a sampling function with parameter m;

taking an inner product between the input signal and the sampling function and outputting an inner product operating value; and

when there is a point at which a difference between the sampling value and the inner product operating value exceeds a specified threshold value,

determining the point to be a changing point and outputting

a changing point signal indicating the changing point.

49. A signal processing method comprising the steps of:

sampling an input signal and outputting a discrete signal composed of a string of sampling values;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and outputting a plurality of inner product operating values;

determining parameter m providing a minimum error out of a plurality of errors derived from differences between the sampling value and the plurality of inner product operating values;

when there is a point at which the difference exceeds a specified threshold value with respect to any parameters m, determining the point to be a changing point and outputting a changing point signal indicating the changing point; and

outputting a combination of the discrete signal, the parameter m signal, and the changing point signal.

50. A signal processing method comprising the steps of:

sampling an input signal to acquire a sampling value; and

detecting a changing point for the input signal based on a difference between the sampling value and a value resulting from an inner product operation between the input signal and a sampling function corresponding to the input signal.

51. A signal processing method comprising the steps of:

sampling an input signal and outputting a signal indicating a sampling value;

determining parameter m in a fluency signal space corresponding to the input signal;

when there is a point at which a difference between the sampling value and a value resulting from an inner product operation between a sampling function and the input signal exceeds a specified threshold value with respect to any parameters m, determining the point to be a changing point; and

outputting a combination of a first signal indicating the sampling value, a second signal indicating the parameter m, and a third signal indicating the changing point.

52. A signal processing program that makes a computer execute the steps of:

sampling an input signal to acquire a sampling value;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and outputting a plurality of inner product operating values; and

when there is a point at which a difference between the sampling value and the plurality of inner product operating values exceeds a specified threshold value with respect to any parameters m, determining the point to be a changing point and

outputting a changing point signal indicating the changing point.

53. A signal processing program that makes a computer execute the steps of:

sampling an input signal to acquire a sampling value; and

detecting a changing point for the input signal based on a difference between the sampling value and a value resulting from an inner product operation between the input signal and a sampling function corresponding to the input signal.

54. A recording medium recording a signal processing program for a computer to process input signals, wherein the signal processing program makes a computer execute the steps of:

sampling an input signal to acquire a sampling value;

generating a plurality of sampling functions with parameters m different from each other;

taking an inner product between the input signal and each of the plurality of sampling functions and output a plurality of inner product operating values; and

when there is a point at which a difference between the sampling value and the plurality of inner product operating values exceeds a specified threshold value with respect to any parameters m, determining the point to be a changing point and output a changing point signal indicating the changing point.

55. A recording medium recording a signal processing

program for a computer to process input signals, wherein the signal processing program makes a computer execute the steps of:

sampling an input signal to acquire a sampling value; and

detecting a changing point for the input signal based on a difference between the sampling value and a value resulting from an inner product operation between the input signal and a sampling function corresponding to the input signal.

56. A signal processing method comprising steps of:

making a continuous signal discrete by AD conversion using a class-m AD function to generate a discrete value string;

determining class m;

interpolating and processing the discrete value string with a DA function selected by the class m using the discrete value string and the class m; and

converting the discrete value string into a continuous signal.

57. A signal processing method comprising the steps of:

making a continuous signal discrete by AD conversion using a class-m AD function to generate a discrete value string;

determining class m;

recording the discrete value string and the class m on a recording medium;

reading the recorded discrete value string and class m from the recording medium;

interpolating and processing the discrete value string by using a DA function selected by the class m; and

converting the discrete value string into a continuous signal.

58. A signal processing method comprising the steps of:

making a continuous signal discrete by AD conversion using a class-m AD function to generate a discrete value string;

determining class m;

transmitting the discrete value string and the class m using a communication means;

reading the discrete value string and the class m from a signal received by the communication means;

interpolating and processing the discrete value string by using a DA function selected by the class m; and

converting the discrete value string into a continuous signal.